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Comparative Studies on Soil Quality Evaluation (For Heavy Metals) in Coastal Region of PSR Nellore Dist, Andhra Pradesh, India

C. Masthan, P. Muni Nagendra Prasad, O. Audi Seshaiah, Y. V. Rami Reddy

Department of Chemistry, S.V.University, Tirupati-517502, Chittor District, Andhra Pradesh, India
Email: muninagendra[at]gmail.com / dryvrsvu[at]gmail.com

Abstract: ***PSR Nellore district is famous for agricultural and Aquaculture activities in Andhra Pradesh. The study has been conducted in coastal region of Nellore district to understand the contamination levels of heavy metals in both agricultural land soil and aquaculture land soils in two consequent years. For this Study each year 21 soil samples were collected in 12 mandals of Coastal Region of PSR Nellore Dist, A.P. India in April 2018 and March 2019. The soil sampling was performed in-line to USEPA soil sampling guidelines. Each soil samples were collected in three different depths (30centimeter depth, 60 centimeters depth and 90 centimeters depth) from surface level and made the grab sample and made homogeneous sample. The homogeneous sample is used for the determination of heavy metals. The concentration of heavy metals was measured by using inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). To assure the quality and accuracy of the results the same samples were analyzed alternative techniques like AAS & ICP-MS techniques. The comparative studies of each metal in two different years and different techniques have been summarized in this study. The data of two consequent years are graphically represented.***

Keywords: PSR, Nellore District, Coastal Region, Heavy metals contamination, Soils, ICP, OES, AAS, ICPMS, Comparative studies

1. Introduction

India is one of the largest producers of agriculture and aquaculture in the World. Andhra Pradesh economy is mainly based on agriculture and aquaculture activities. SPSR Nellore district is one of the most populous districts in Andhra Pradesh. Nellore is one of the famous districts for Agriculture and Aquaculture activities. Yearly more than 86000 tons of sea food is exporting from Krishna Patnam Port. The Soil is most important natural resource and the soil will play key role in agriculture and Aquaculture activities. Soil is composed of mineral constituents, organic matter (humus), living organisms, air, and water, and it regulates the natural cycles of these components. [2, 3]

More than 20 crop varieties are cultivating in Nellore district due to the different varieties of soils nature in Nellore district. [4]

Heavy metals are the elements with a density greater than 5g / cm³. They can be found in air, water and soil. These metals often interfere with the normal course of metabolic processes even in trace amounts, causing several diseases and act by accumulation effects, with an exception of low tolerable doses. Such metals often have a toxic effect, so their presence in the aquatic ecosystem process risks to human health and causes harmful effects to living organisms [5]. Heavy metals occur naturally in soils, which are formed by geological processes, such as alteration and erosion of the geological underground materials [6, 7].

In soils migration of heavy metals takes place due to mass transfer, which involves water carrier, diffusion. Migration of metals in soils depends on various properties of soil [8]. Soil pollution by heavy metals has serious health implication especially with regards to crops/vegetables grown on such soils [9, 10]. Heavy metals occupy a special position in soil chemistry because they play very important physiological roles in nature [11, 12].

Study of heavy metals in soil is very important because of soil is interlinked with ground water surface water, crop and Aquaculture. If the soils are contaminated with heavy metals or higher concentrations of heavy metals in soil there may be a chance to bioaccumulation of these heavy metals into crop that may effect on the human health, and also there may be a chance to leach of heavy metals into water bodies.

The metals are classified as “heavy metals” if in their standard state they have a specific gravity of more than 5 g/cm^3. There are known sixty heavy metals. Heavy metals get accumulated in time in soils and plants and could have a negative influence on physiological activities of plants (e.g. photosynthesis, gaseous exchange, and nutrient absorption), determining the reductions in plant growth, dry matter accumulation and yield [13, 14]. In small concentrations, the traces of the heavy metals in plants or animals are not toxic [15] Lead, Cadmium and mercury are exceptions; they are toxic even in very low concentrations [16].

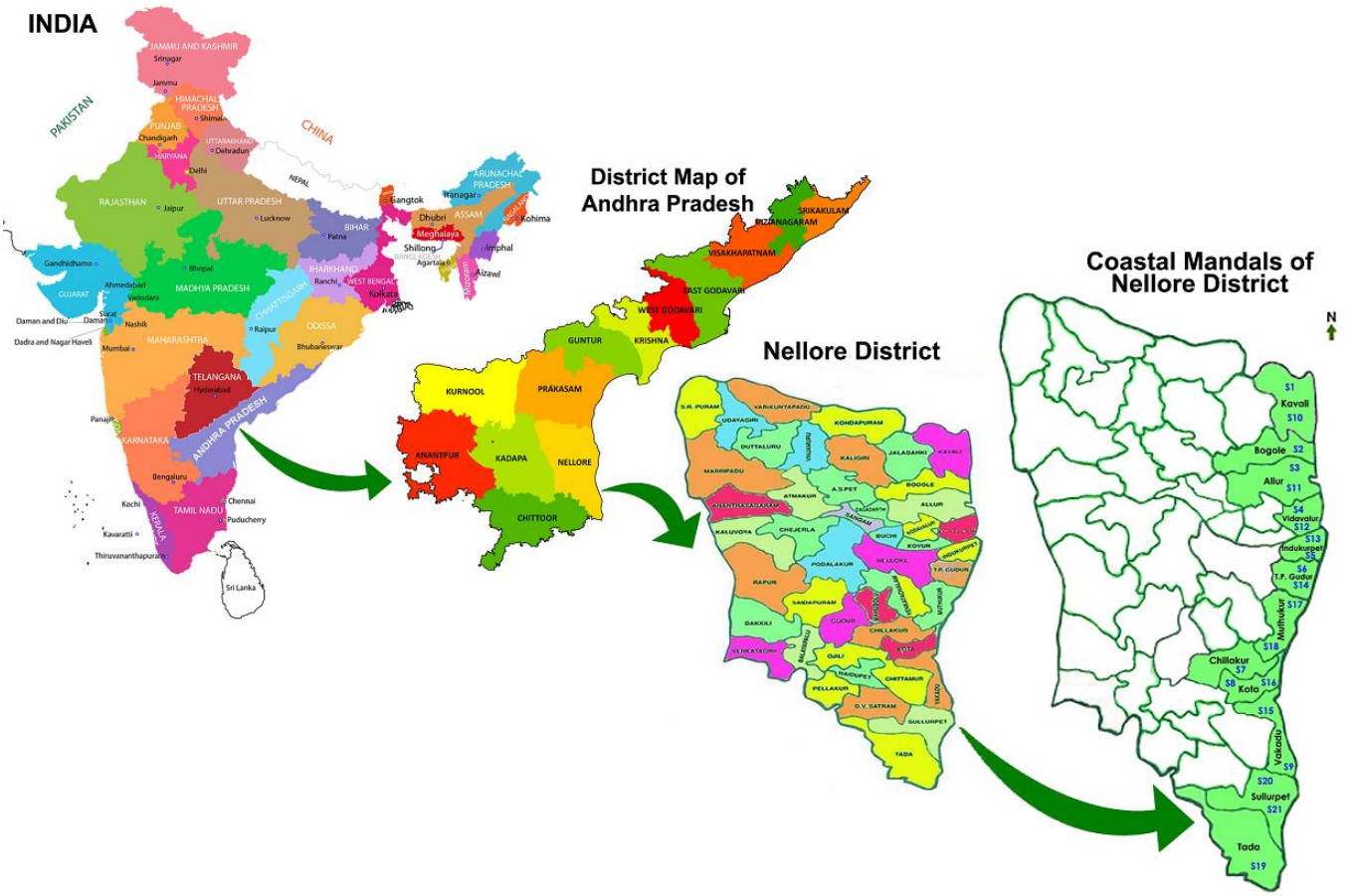
Heavy metals can be found generally at trace levels in soil and vegetation, and living organisms feel the need for micro-elements of these metals. However, these have a toxic effect on organisms at high content levels. Heavy metal toxicity has an inhibitory effect on plant growth, enzymatic activity, stoma function, photo-synthesis activity and accumulation of other nutrient elements, and also damages the root system [17].

There are several studies on heavy metals determination in water, soil and air quality monitoring due to, industrial and domestic sectors to know the environmental pollution.

Hence, the aim of the present study is to understand the levels of heavy metals in soils of coastal areas of SPSR Nellore district, Andhra Pradesh, India.

Study Location:

Study locations were identified in the below map.



Sampling Methodology / Sample collection Methodology:

All soil samples were collected from different Coastal areas of SPSR Nellore district as per USEPA soil sampling guidelines. . Each sample was collected in three depths (surface, 30centimeters depth, 60 centimeters depth and 90 centimeters depth) and mixed thoroughly. The mixed sample is then oven-dried at 70°C for 48 hrs before and made fine particles using mortar with pestle.

Sample Preparation / Sample Digestion Procedure:

These homogeneous samples were used for metal digestion. 1.0 g finely grinded and dried soil samples were taken in cleaned microwave digestion vessel and added 7 mL of concentrated HNO_3, 1 mL of HCl and 2 mL of Hydrogen Peroxide solutions. Closed the lid of vessel and digested by using microwave digestion system. After completion of digestion, the system was cooled and removed the vessels from Microwave digestion. The samples were filtered by using watman no. 42 filter paper and collected the filtrate in 50 mL Volumetric flask and made the final volume up to 50 mL by using diluents as 2 % Nitric acid solution.

Principle and sample analysis by ICP:

Radio frequency induction of Argon takes place and generates a high temperature nearly 6000ºK. Sample is introduced into mixing chamber and the sample is mixed with argon gas, sample is converted into aerosol form. Only fine droplets or aerosol can enter into the plasma temperature. At that temperature interferences of other elements can eliminate. Each element has its characteristic wavelength. At that characteristic wavelength the intensity of each element can be measured.

Before doing the analysis external calibration can be made by using five linear multi element standards were used which is traceable to NIST and observed good linear correlation coefficient for all metals (>0.995). Quality Control check results were observed within the satisfactory levels.

Operating conditions of ICP-OES:

Power: 1200 watts
Nebulizer Flow: 0.8 L / min
Auxiliary Flow: 1.2 L/ min
Viewing Height: 10

ICP - MS Analysis - Instrument Operational Conditions:

- Mass range: 6 to 240 amu
- ICP-RF power: 1500 W (500 to 1600 W)
- RF matching: 1.62 V (0.2 to 3.0 V)
- Detector mode: Pulse and Analog counting
- Sampling depth: 7 to 10 mm (3.0 to 28.0 mm)
- Carrier gas: 0.9 L /min (0.0 to 2 L/min)
- Makeup gas: 0.1 to 0.3 L /min (0.0 to 2 L/min)
- Auxiliary gas: 1 L /min
- Plasma gas: 15 L /min
- Nebulizer pump: 0.1 rps (0.0 to 0.5 rps)
- Solution uptake rate: 0.5 mL/min (0 to 0.5 mL/min)
- Sample pump: 0.1 rps (0 to 0.5 mL/min)
- Stabilization time: 40 sec
- S /C temperature: 2 degree
- Replicate integration's: 3 (3 to 100)
- Extract 1 (V): -200 to 10 V
- Extract 2 (V): -250 to 10 V
- Omega Bias -ce (V): -150 to 10 V
- Omega lens-ce (V): -50 to 50 V
- Cell entrance (V): -150 to 10 V
- Cell exit (V): -150 to 10 V
- 1Deflect (V): -150 to 20 V
- Plate Bias (V): -150 to 10 V
- Oct P RF (V): 30 to 200 V
- Oct P Bias (V): - 150 to 20 V

*The above tune values may change based on instrument tuning.

Operation of ICP –MS

- Set the gas supplies:

Argon gas: 500-700 kpa
Helium gas: 90-130 kpa
Optional gas: 10-100 kpa (20% Oxygen gas / 80% Argon gas)

- Cooling water conditions:

Pressure: 230-350 kpa (2.3 ~ 4.1 kg/cm2 or 33 ~ 58 psi)
Temperature: 15-40 °C
Flow rate: 5.0 L /min.
Exhaust vent: 5.0 to 7 m³ /min (4.7-6.6 m/sec) or 177 f t3/min (17.8 ft/sec)

2. Results and Discussion

Twenty one soil samples were collected in 12 mandals of coastal areas of SPSR Nellore district in two consequent years and analyzed for Pb, Cd, Co, Fe, Cr, Cu, Mn and Zn by ICP-OES and ICP-MS. Sampling location details and the heavy metals concentration levels and comparative studies were summarized in Table -1 and Table -2 and results were discussed below. The graphical representation of each metal is summarized.

Location Name	
Soil sample -1 (Annemadugu-Aqua-KavaliMandal)	Soil sample -12 (Parlapalli_Paddy-Vidavalur Mandal)
Soil sample -2 (Vulavapalla-Paddy-BogoluMandal)	Soil sample -13 (Pallepadu-Aqua-IndukurupetaMandal)
Soil sample -3 (Allur-Aqua-AllurMandal)	Soil sample-14 (Narukuru-Paddy-TPgudurMandal)
Soil sample -4 (Parlapalli-Aqua-VidavalurMandal)	Soil sample -15 (Thupilipalem-Aqua-Vakadu mandal)
Soil sample -5 (Pallepadu-Paddy-IndukurupetMandal)	Soil sample -16 (Balireddypalem-Aqua-Kota Mandal)
Soil sample -6 (Narukuru-Aqua-TP gudurMandal)	Soil sample -17 (Malluru-Paddy-Muthukur Mandal)
Soil sample -7 (Varagali-Paddy-ChillakurMandal)	Soil sample -18 (KrishnaPatnamPort-Paddy-Muthukur Mandal)
Soil sample -8 (Kadivedu-Paddy-KotaMandal)	Soil sample -19 (Kadalur-Paddy-Tada Mandal)
Soil sample -9 (Vakadu-Paddy-VakaduMandal)	Soil sample -20 (Sriharikota-Paddy-SullurpetaMandal)
Soil sample -10 (Kattakinda palem-Paddy-KavaliMandal)	Soil sample -21 (Sarvareddy kandriga-paddy-SullurpetaMandal
Soil sample -11 (Iskapalli-Paddy-AllurMandal)	

	Cadmium as Cd (mg/kg)						Cobalt as Co (mg/kg)					
	Y-2018			Y-2019			Y-2018			Y-2019		
	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation
S-1	0.200	0.210	-4.9	0.210	0.230	-9.5	1.862	1.660	10.8	2.900	3.200	-10.3
s-2	0.073	0.080	-10.3	0.140	0.130	7.1	1.980	2.210	-11.6	3.200	2.990	6.6
S-3	0.218	0.190	12.6	0.190	0.200	-5.3	9.543	9.220	3.4	8.800	8.100	8.0
S-4	0.278	0.260	6.4	0.250	0.240	4.0	14.330	13.400	6.5	15.600	15.000	3.8
S-5	0.193	0.220	-13.9	0.330	0.310	6.1	10.691	10.220	4.4	13.800	14.100	-2.2
S-6	0.208	0.180	13.3	0.360	0.340	5.6	1.880	1.550	17.6	3.100	2.900	6.5
S-7	0.058	0.055	4.5	0.140	0.150	-7.1	2.330	2.010	13.7	3.500	3.100	11.4

S-8	0.153	0.180	-18.0	0.110	0.123	-11.8	3.210	3.000	6.5	2.900	3.400	-17.2
S-9	0.273	0.240	12.1	0.410	0.440	-7.3	1.980	2.110	-6.6	2.900	2.700	6.9
S-10	0.067	0.080	-19.1	0.420	0.390	7.1	3.830	3.110	18.8	2.500	2.700	-8.0
S-11	0.240	0.230	4.3	0.440	0.440	0.0	3.200	3.000	6.3	3.900	3.700	5.1
S-12	0.195	0.210	-7.7	0.390	0.350	10.3	9.782	8.800	10.0	7.400	8.100	-9.5
S-13	0.130	0.110	15.7	0.190	0.220	-15.8	3.870	3.500	9.6	4.200	5.100	-21.4
S-14	0.191	0.210	-9.9	0.440	0.390	11.4	2.400	2.500	-4.2	3.600	4.100	-13.9
S-15	0.178	0.180	-1.3	0.210	0.230	-9.5	10.681	9.200	13.9	12.100	12.900	-6.6
S-16	0.176	0.210	-19.1	0.200	0.220	-10.0	9.620	9.000	6.4	11.000	11.800	-7.3
S-17	0.198	0.230	-16.4	0.340	0.350	-2.9	9.983	8.100	18.9	12.900	13.500	-4.7
S-18	0.272	0.290	-6.5	0.360	0.350	2.8	5.407	4.800	11.2	9.900	9.100	8.1
S-19	0.302	0.330	-9.2	0.330	0.350	-6.1	6.271	5.500	12.3	9.500	10.200	-7.4
S-20	0.180	0.150	16.5	0.290	0.280	3.4	1.990	1.700	14.6	3.200	3.400	-6.2
S-21	0.095	0.080	16.1	0.144	0.150	-4.2	4.120	3.300	19.9	8.100	8.800	-8.6
Minimum	0.058	0.055		0.110	0.123		1.862	1.550		2.500	2.700	
Maximum	0.302	0.330		0.440	0.440		14.330	13.400		15.600	15.000	
Average	0.185	0.187		0.281	0.280		5.665	5.138		6.905	7.090	

	Chromium as Cr (mg/kg)						Copper as Cu (mg/kg)					
	Y-2018			Y-2019			Y-2018			Y-2019		
	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation
S-1	30.500	28.900	5.2	33.900	35.100	-3.5	10.499	12.100	-15.2	12.800	13.100	-2.3
s-2	52.122	48.100	7.7	46.900	45.100	3.8	30.347	28.100	7.4	42.800	40.900	4.4
S-3	26.275	28.990	-10.3	24.200	25.100	-3.7	8.265	9.300	-12.5	11.900	12.900	-8.4
S-4	23.673	25.100	-6.0	18.900	19.100	-1.1	11.948	10.500	12.1	12.100	13.100	-8.3
S-5	23.774	25.200	-6.0	31.400	32.100	-2.2	9.733	10.100	-3.8	17.900	18.300	-2.2
S-6	43.042	40.100	6.8	46.700	45.100	3.4	22.012	21.200	3.7	18.200	19.900	-9.3
S-7	22.020	20.400	7.4	33.800	35.100	-3.8	8.687	9.300	-7.1	15.700	16.100	-2.5
S-8	39.584	38.100	3.7	33.200	35.600	-7.2	17.968	16.200	9.8	29.800	30.400	-2.0
S-9	33.855	35.100	-3.7	38.900	32.900	15.4	13.513	13.400	0.8	23.100	24.100	-4.3
S-10	41.174	39.900	3.1	47.800	48.100	-0.6	15.328	16.100	-5.0	19.700	20.500	-4.1
S-11	36.628	37.100	-1.3	45.100	47.100	-4.4	15.847	15.900	-0.3	13.500	15.000	-11.1
S-12	55.482	54.800	1.2	66.900	64.300	3.9	7.133	8.100	-13.5	12.800	13.400	-4.7
S-13	44.420	42.100	5.2	40.100	42.900	-7.0	22.596	20.900	7.5	19.100	19.900	-4.2
S-14	27.605	30.100	-9.0	36.900	38.100	-3.3	14.424	14.900	-3.3	16.100	17.500	-8.7
S-15	24.445	25.100	-2.7	20.600	22.500	-9.2	10.226	10.500	-2.7	12.400	13.100	-5.6
S-16	29.460	28.100	4.6	33.800	35.500	-5.0	9.551	10.100	-5.7	11.800	13.100	-11.0
S-17	26.189	25.500	2.6	38.400	35.100	8.6	13.697	14.100	-2.9	12.900	13.400	-3.9
S-18	48.071	45.100	6.2	54.900	50.400	8.2	24.727	22.600	8.6	33.700	34.100	-1.2
S-19	38.293	40.100	-4.7	44.900	42.100	6.2	14.057	15.100	-7.4	24.200	25.300	-4.5
S-20	47.628	45.200	5.1	55.900	54.200	3.0	23.574	24.100	-2.2	28.100	27.100	3.6
S-21	47.184	44.100	6.5	49.900	47.100	5.6	17.071	18.100	-6.0	26.100	24.100	7.7
Minimum	22.020	20.400		18.900	19.100		7.133	8.100		11.800	12.900	
Maximum	55.482	54.800		66.900	64.300		30.347	28.100		42.800	40.900	
Average	36.258	35.580		40.148	39.648		15.295	15.271		19.748	20.252	

	Iron as Fe (mg/kg)						Manganese as Mn (mg/kg)					
	Y-2018			Y-2019			Y-2018			Y-2019		
	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation
S-1	6738.4	6992.0	-3.8	7281.0	7099.0	2.5	165.091	160.200	3.0	144.300	150.900	-4.6
s-2	19124.2	19012.0	0.6	16229.0	16034.0	1.2	591.290	562.100	4.9	432.800	450.100	-4.0
S-3	6209.4	6102.0	1.7	7322.0	7302.0	0.3	230.000	222.100	3.4	360.100	372.900	-3.6
S-4	7310.7	7033.0	3.8	6544.0	6608.0	-1.0	421.725	401.300	4.8	344.600	362.900	-5.3
S-5	6691.4	6522.0	2.5	7521.0	7504.0	0.2	152.523	159.300	-4.4	176.000	188.200	-6.9
S-6	13534.2	13088.0	3.3	11544.0	11498.0	0.4	267.746	255.800	4.5	300.200	322.300	-7.4
S-7	20144.1	21001.0	-4.3	18775.0	18998.0	-1.2	62.279	72.100	-15.8	78.000	80.900	-3.7
S-8	12148.9	12110.0	0.3	14556.0	15033.0	-3.3	305.780	292.200	4.4	240.200	255.200	-6.2
S-9	9963.5	9899.0	0.6	12245.0	12098.0	1.2	285.005	300.100	-5.3	334.000	359.100	-7.5

S-10	13942.6	13098.0	6.1	11023.0	11680.0	-6.0	596.200	580.100	2.7	513.000	533.200	-3.9
S-11	10515.1	10098.0	4.0	9899.0	9553.0	3.5	493.085	480.300	2.6	444.000	470.100	-5.9
S-12	6737.7	6659.0	1.2	8849.0	8099.0	8.5	448.049	420.400	6.2	535.000	544.500	-1.8
S-13	14495.6	14098.0	2.7	11231.0	11881.0	-5.8	369.920	349.200	5.6	409.000	432.800	-5.8
S-14	9378.3	9023.0	3.8	12098.0	11042.0	8.7	227.677	239.300	-5.1	299.000	309.300	-3.4
S-15	6870.2	6701.0	2.5	8894.0	8550.0	3.9	155.074	170.100	-9.7	199.000	209.400	-5.2
S-16	6866.4	6700.0	2.4	9091.0	9134.0	-0.5	250.798	240.200	4.2	309.000	322.800	-4.5
S-17	8205.9	8029.0	2.2	10991.0	10010.0	8.9	470.562	440.200	6.5	403.000	408.100	-1.3
S-18	15026.3	14094.0	6.2	13110.0	12881.0	1.7	294.101	321.200	-9.2	322.000	312.900	2.8
S-19	10988.1	10014.0	8.9	9942.0	9812.0	1.3	309.028	333.000	-7.8	378.000	399.400	-5.7
S-20	15403.9	14990.0	2.7	14011.0	13009.0	7.2	379.364	393.000	-3.6	450.000	469.900	-4.4
S-21	15101.9	14874.0	1.5	16991.0	16001.0	5.8	645.630	670.900	-3.9	522.000	542.400	-3.9
Minimum	6209.440	6102.000		6544.000	6608.000		62.279	72.100		78.000	80.900	
Maximum	20144.140	21001.000		18775.000	18998.000		645.630	670.900		535.000	544.500	
Average	11209.397	10958.905		11340.333	11134.571		339.092	336.338		342.533	357.014	

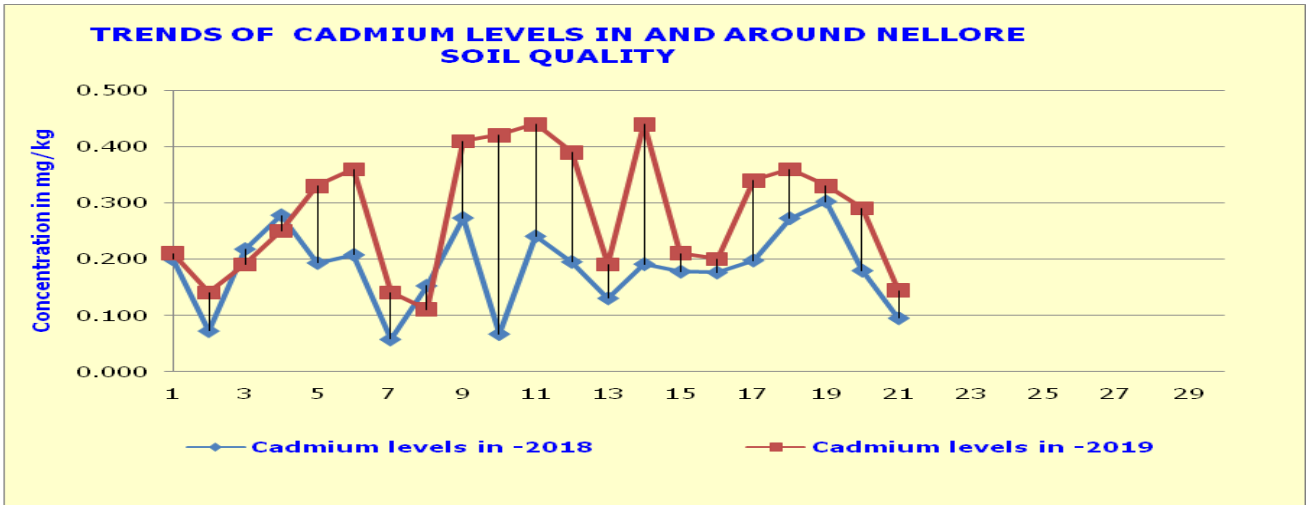
	Nickel as Ni (mg/kg)						Lead as Pb (mg/kg)					
	Y-2018			Y-2019			Y-2018			Y-2019		
	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation
S-1	15.539	14.100	9.3	12.100	12.900	-6.6	15.883	14.900	6.2	19.200	18.400	4.2
s-2	29.892	28.400	5.0	22.900	23.500	-2.6	32.243	31.500	2.3	25.200	26.900	-6.7
S-3	11.000	10.900	0.9	9.600	10.600	-10.4	22.250	22.900	-2.9	29.200	28.900	1.0
S-4	15.848	14.800	6.6	12.100	12.900	-6.6	19.527	20.500	-5.0	18.800	19.200	-2.1
S-5	13.062	12.200	6.6	15.300	14.800	3.3	17.327	18.400	-6.2	19.500	18.800	3.6
S-6	28.823	24.400	15.3	22.500	23.400	-4.0	46.700	44.900	3.9	40.200	42.200	-5.0
S-7	7.331	8.000	-9.1	10.900	11.700	-7.3	40.330	42.200	-4.6	35.300	37.400	-5.9
S-8	18.091	17.100	5.5	19.800	18.300	7.6	40.630	41.900	-3.1	30.800	32.200	-4.5
S-9	19.436	19.900	-2.4	22.100	21.500	2.7	27.191	26.200	3.6	39.200	38.800	1.0
S-10	28.279	27.500	2.8	19.200	18.900	1.6	23.088	22.000	4.7	18.200	19.200	-5.5
S-11	20.815	20.500	1.5	16.400	15.300	6.7	78.195	75.100	4.0	50.500	48.100	4.8
S-12	10.585	9.400	11.2	15.900	16.500	-3.8	21.302	22.800	-7.0	22.900	21.000	8.3
S-13	25.710	24.100	6.3	18.400	17.900	2.7	36.080	34.800	3.5	33.400	32.900	1.5
S-14	17.476	17.200	1.6	22.500	23.700	-5.3	54.577	50.300	7.8	45.500	44.200	2.9
S-15	13.167	12.900	2.0	18.500	17.200	7.0	18.071	20.100	-11.2	30.400	28.100	7.6
S-16	12.157	13.400	-10.2	16.300	15.100	7.4	21.745	20.600	5.3	28.400	26.900	5.3
S-17	16.737	15.200	9.2	22.100	21.100	4.5	25.578	26.900	-5.2	19.800	22.500	-13.6
S-18	30.382	29.300	3.6	39.400	37.900	3.8	29.136	28.200	3.2	40.900	42.100	-2.9
S-19	20.476	18.400	10.1	22.100	22.000	0.5	28.890	27.500	4.8	23.400	22.100	5.6
S-20	26.730	27.500	-2.9	34.100	33.100	2.9	35.456	33.900	4.4	30.600	31.900	-4.2
S-21	28.243	28.900	-2.3	22.600	23.400	-3.5	26.546	27.700	-4.3	22.100	23.500	-6.3
Minimum	7.331	8.000		9.600	10.600		15.883	14.900		18.200	18.400	
Maximum	30.382	29.300		39.400	37.900		78.195	75.100		50.500	48.100	
Average	19.513	18.767		19.752	19.605		31.464	31.110		29.690	29.776	

	Zinc as Zn (mg/kg)					
	Y-2018			Y-2019		
	ICP-OES	AAS	% of Variation	ICP-OES	ICP-MS	% of Variation
S-1	15.062	14.600	3.1	22.500	23.800	-5.8
s-2	33.223	30.900	7.0	29.200	29.900	-2.4
S-3	19.200	22.200	-15.6	26.400	28.800	-9.1
S-4	20.059	20.400	-1.7	18.200	19.100	-4.9
S-5	32.254	29.800	7.6	33.900	30.400	10.3
S-6	31.035	28.000	9.8	40.400	38.800	4.0
S-7	22.453	23.900	-6.4	29.100	31.200	-7.2
S-8	27.546	28.800	-4.6	44.000	40.100	8.9
S-9	23.190	23.400	-0.9	30.100	28.900	4.0
S-10	23.774	24.500	-3.1	22.500	21.800	3.1
S-11	29.325	29.400	-0.3	39.600	37.900	4.3
S-12	13.818	14.100	-2.0	21.800	20.800	4.6
S-13	36.110	35.100	2.8	30.300	32.500	-7.3
S-14	30.160	31.200	-3.4	33.100	31.800	3.9
S-15	31.047	30.800	0.8	40.500	37.500	7.4

S-16	18.732	19.100	-2.0	28.900	26.400	8.7
S-17	23.092	23.300	-0.9	20.500	22.500	-9.8
S-18	35.448	34.100	3.8	30.100	28.500	5.3
S-19	25.635	27.800	-8.4	29.100	30.900	-6.2
S-20	36.786	34.200	7.0	30.600	31.800	-3.9
S-21	26.672	27.200	-2.0	22.100	23.800	-7.7
Minimum	13.818	14.100		18.200	19.100	
Maximum	36.786	35.100		44.000	40.100	
Average	26.410	26.324		29.662	29.390	

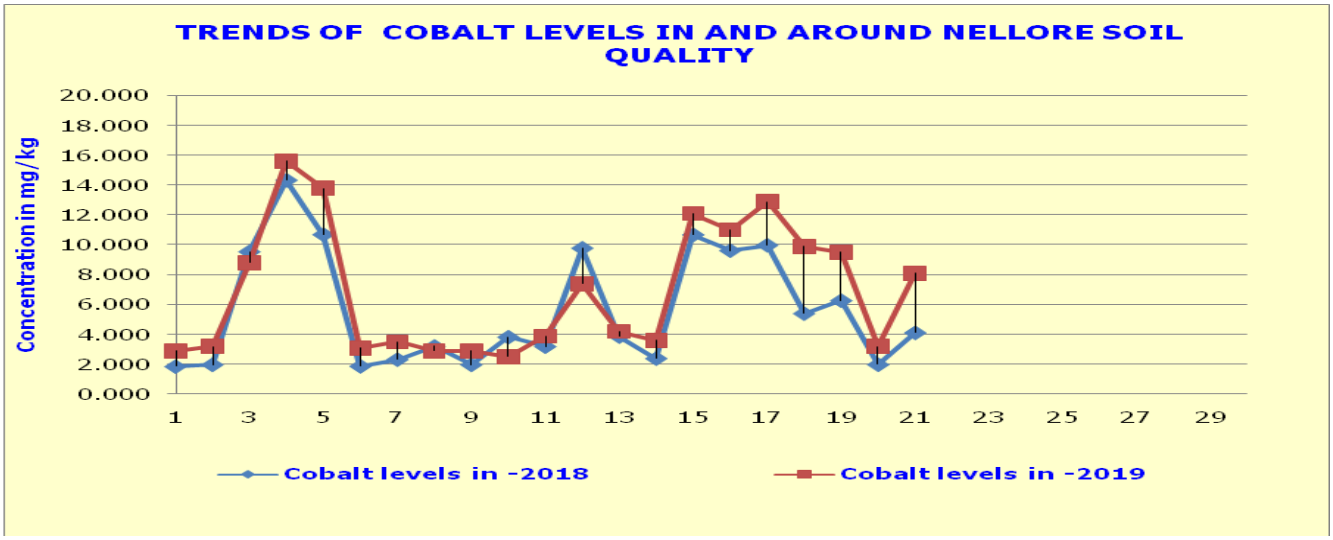
Cadmium:

Cadmium concentration is ranging from 0.058 mg/kg to 0.302 mg/kg in year 2018 and 0.11 mg/g to 0.44 mg/kg in year 2019. The highest Cadmium concentration observed in S-18 (krishnapatnam port) and lowest concentration observed in S-7 (Varagali-Paddy-Chillakur Mandal) in year 2018 and the highest Cadmium concentration observed in S-11 (Iskapalli-Paddy-Allur Mandal) and lowest concentration observed in S -8 (Kadivedu-Paddy-Kota Mandal).



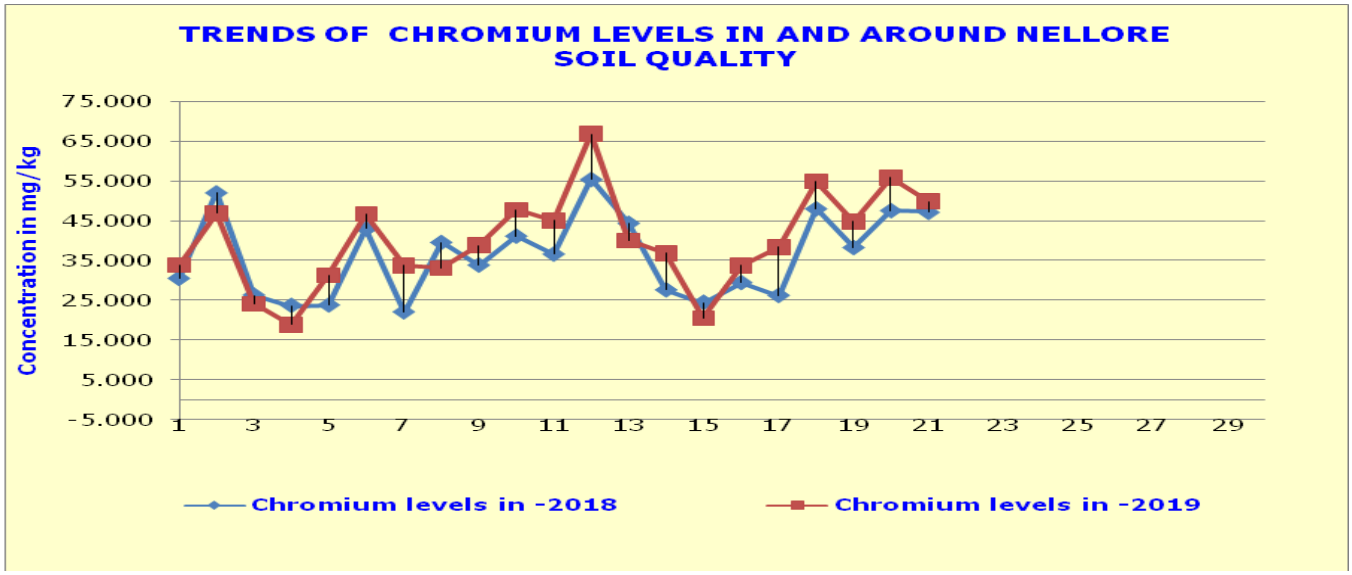
Cobalt:

Cobalt concentration is ranging from 1.86 mg/kg to 14.33 mg/kg in year 2018 and 2.5 mg/kg to 15.5 mg/kg in year 2019. The highest Cobalt concentration observed in S-4 (Parlapalli-Aqua-Vidavalur Mandal) and lowest concentration observed in S-1 (Annemadugu-Aqua-Kavali Mandal) in year 2018 and the highest Cobalt concentration observed in S-4 (Parlapalli-Aqua-Vidavalur Mandal) and lowest concentration observed in S-10 (Kattakinda palem-Paddy-Kavali Mandal) in year 2019.



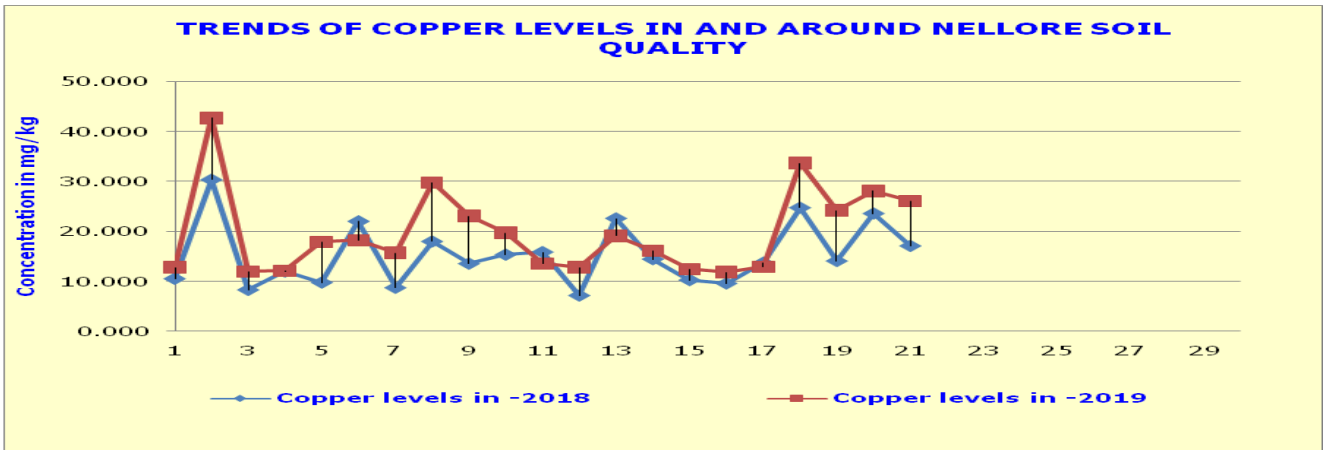
Chromium:

Chromium concentration is ranging from 22.0 mg/kg to 55.48 mg/kg in year 2018 and 18.9 mg/kg to 66.9 in year 2019. The highest Chromium concentration observed in S-12 (Parlapalli_Paddy-) and lowest concentration observed in S-7 (Varagali-Paddy-Chillakur Mandal) in year 2018 and the highest concentration of Chromium observed at S-12 (Parlapalli_Paddy-) and lowest concentration observed at S-4 (Parlapalli-Aqua-Vidavalur Mandal) in year 2019.



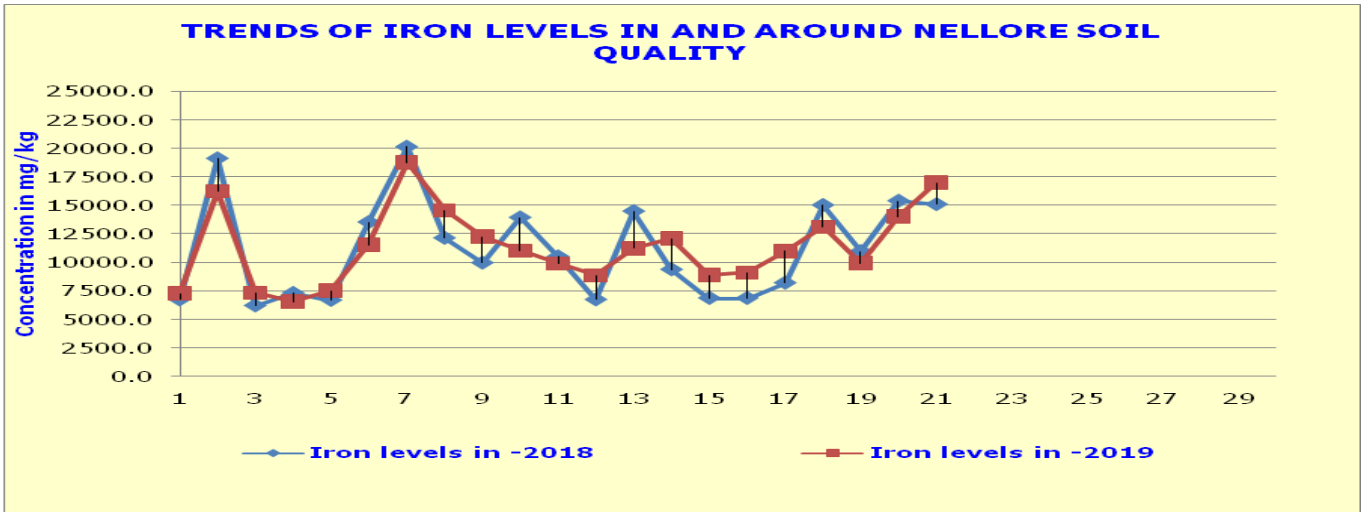
Copper:

Copper concentration is ranging from 7.133 mg/kg to 30.35 mg/kg in year 2018 and 11.8 mg/kg to 42.8 mg/kg in year 2019. The highest Copper concentration observed in S-2 (Vulavapalla-Paddy-Bogolu Mandal) and lowest concentration observed in S-12 (Parlapalli_Paddy-) in year 2018 and the highest concentration of Copper observed at S-2 (Vulavapalla-Paddy-BogoluMandal) and lowest concentration of copper observed at S-16 (Balireddypalem-Aqua-Kota Mandal) in year 2019.



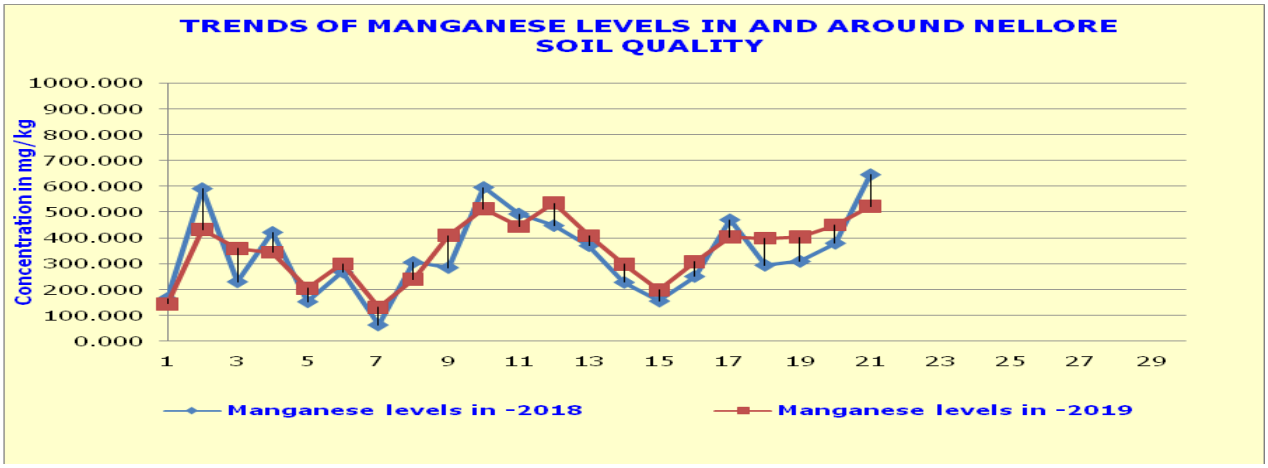
Iron:

Iron concentration is ranging from 6209 mg/kg to 20144.1 mg/kg in year 2018 and 6544 mg/kg to 18577 mg/kg in year 2019. The highest Iron concentration observed in S-7 (Varagali-Paddy-Chillakur Mandal) and lowest concentration observed in S -3 (Allur-Aqua-Allur Mandal) in year 2018 and the highest concentration of Iron was observed at S-7 (Varagali-Paddy-Chillaku rMandal) and lowest concentration was observed at S-4 (Parlapalli-Aqua-Vidavalur Mandal) in year 2019.



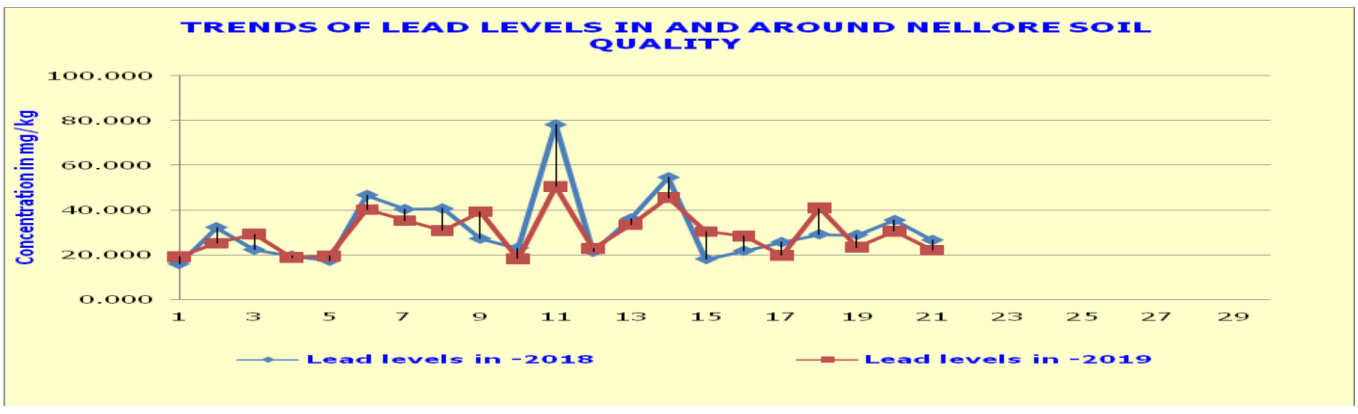
Manganese:

Manganese concentration is ranging from 62.279 mg/kg to 645.63 mg/kg in year 2018 and 78 mg/kg to 535 mg/kg in year 2019. The highest Manganese concentration observed in S-21 (Sarvareddy kandriga-paddy-Sullurpeta Mandal and lowest concentration observed in S-7 (Varagali-Paddy-Chillakur Mandal) in year 2018 and the highest concentration of Mn was observed at S-12 (Parlapalli_Paddy-) and lowest in S-7 (Varagali-Paddy-Chillakur Mandal).



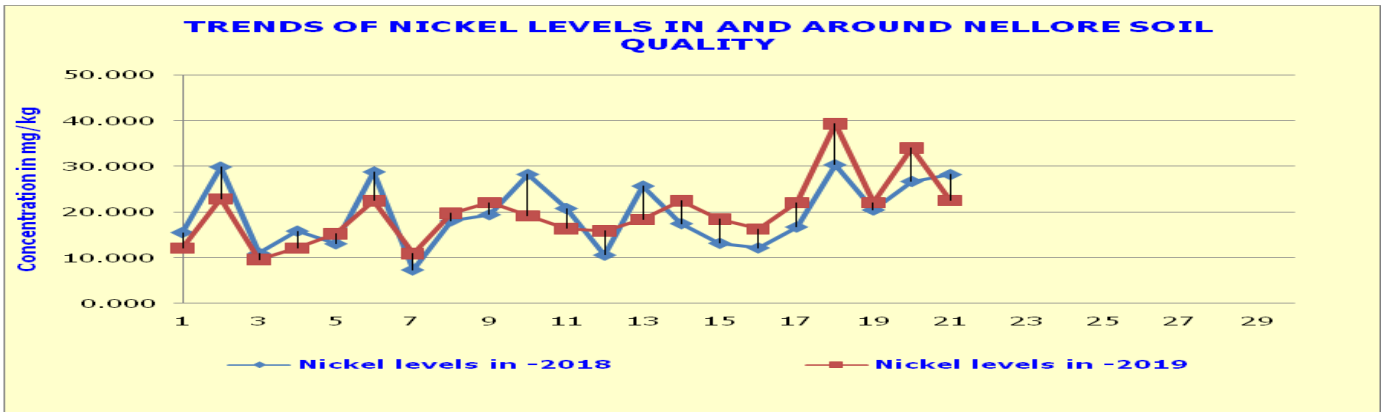
Lead:

Lead concentration is ranging from 15.88 mg/kg to 78.19 mg/kg in year 2018 and 18.2 mg/kg to 50.5 mg/kg in year 2019. The highest lead concentration observed in S-18 (Krishna Patnam Port-Paddy-Muthukur Mandal) and lowest concentration observed in S-1 (Annemadugu-Aqua-Kavali Manda l) in year 2018 and the highest concentration of lead in was observed at S-11 (Iskapalli-Paddy-AllurMandal) and lowest concentration of lead was observed at S-10 (Kattakinda palem-Paddy-Kavali Mandal) in year 2019.



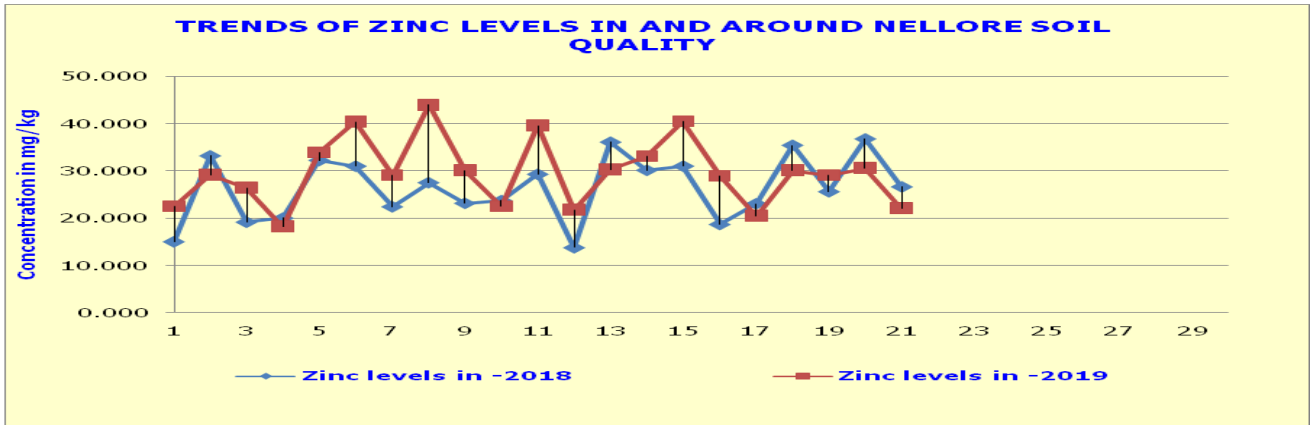
Nickel:

Nickel concentration is ranging from 7.33 mg/kg to 30.38 mg/kg in year 2018 and 9.6 mg/kg to 39.4 mg/kg in year 2019. The highest Nickel concentration observed in S-18 (Krishna Patnam Port-Paddy-Muthukur Mandal) and lowest concentration observed in S-7 (Varagali-Paddy-Chillakur Mandal) in year 2018 and the highest concentration of Nickel was observed at S-18 (Krishna Patnam Port-Paddy-Muthukur Mandal) and lowest concentration of Nickel was observed at S -3 (Allur-Aqua-AllurMandal) in year 2019.



Zinc:

Zinc concentration is ranging from 13.818 mg/kg to 36.786 mg/kg in year 2018 and 18.2 mg/kg to 44.0 mg/kg in year 2019. The highest Zinc concentration observed in S -20 (Sriharikota-Paddy-Sullurpeta Mandal) and lowest concentration observed in S-12 (Parlapalli_Paddy) in year 2018 and the highest concentration of zinc was observed at S -8 (Kadivedu-Paddy-KotaMandal) and lowest concentration of Zinc was observed at S-4 (Parlapalli-Aqua-Vidavalur Mandal) in year 2019 .



3. Conclusion

In this study we made an attempt to know the heavy metals concentrations of Soils in Coastal areas of SPSR Nellore District, A.P. India. This study was conducted in two consequent years to understand the heavy metals pollution levels and also each year the samples were analyzed with two different alternative techniques to establish the reproducibility and accuracy in the data. Based on the two consequent years data it has been observed that there is no high variations observed in the pollutants concentrations in two consequent years. Based on above study, Lead, cadmium, chromium and other toxic metals were present in the Soil samples of both Aquaculture lands and Agricultural lands. It is recommended to increase the frequency for monitoring of Soil, Air and Water pollution in the coastal areas of Nellore district and should take necessary mitigation measures to control the heavy metal pollution at coastal areas of SPS Nellore District because these locations are highly using for Agricultural and Aqua cultural activities.

4. Future Scope

Soil is the one of the most important source for agricultural cultivation. Soil pollution is directly impact on all agricultural products, which is directly impact on human health. Most of agricultural institutions are working on the soil pollution and its mitigation measures. There will be wide future scope on soil research in upcoming years especially in SPSR Nellore district of Andhra Pradesh, India.

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Author Profiles

Professor Y.V. Rami Reddy, Department of Chemistry, S. V. University, Tirupati, Having 25 plus years Research experience in Physical Chemistry, Enviro-Analytical Chemistry.

Mr. Masthan Chemuru, M.Sc., M.Ed., M.Phil. in Chemistry. Having 10 plus years research experience in Environmental Chemistry.

Dr P.Muni Nagendra Prasad, M.Sc, P.hD in Chemistry. Having 15 plus years research experience in Analytical, Food, Water and Environmental Chemistry.

O. Audi Seshaiah, M.Sc, in Chemistry. Having 5 plus years research experience in Analytical/Physical and Environmental Chemistry.